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MULTIMEDIA DEVELOPMENT FOR NIGHT VISION DEVICE AIRCREW TRAINING

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This report describes the development of multimedia training used for night vision device (NVD) aircrew training. The facilities used by the US Air Force, US Navy, and US Marine Corps for NVD training are described. Methods for NVD video acquisition, which is used extensively in the training, are explained. The paper covers the courseware development and delivery techniques used to produce NVD aircrew training. Finally, the paper concludes by addressing emerging multimedia technologies and other NVD subjects that could be taught via multimedia delivery systems.

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PREFACE

This work was conducted at the Armstrong Laboratory, Human Resources Directorate, Aircrew Training Research Division (AL/HRA) at Williams Gateway Airport in Mesa, AZ by the University of Dayton Research Institute (UDRI). Among many other research efforts, AL/HRA conducts visual training effectiveness research in support of aircrew training technology. One entity of this effort is the night vision training research program.

UDRI, working under Contract F33615-90-C-0005, developed prototype instructional media and courseware to be used in aircrew night vision goggle training. This paper describes the development of multimedia training used for night vision device aircrew training. Laboratory contract monitor was Ms Patricia A. Spears for the work performed under Work Unit 1123-03-85, Flying Training Research Support. Dr Elizabeth L. Martin was the laboratory task order monitor for the in-house portion of the effort under Work Unit 1123-B4-01, Night Vision Device Training Research and Development

MULTIMEDIA DEVELOPMENT
FOR NIGHT VISION DEVICE AIRCREW TRAINING

Introduction

The expanded use of night vision devices (NVDs), primarily night vision goggles (NVGs) and forward looking infrared (FLIR) sensors, by aircrew have created the need for comprehensive training on how to use these devices. Emphasis within this training should be on the proper and safe use of these sensors. The University of Dayton Research Institute (UDRI) and the Aircrew Training Research Division of the US Air Force Armstrong Laboratory (AL/HRA) has initiated and continues to develop the night vision aircrew training program, which has become the standard initial training for US Air Force, US Navy, and US Marine Corps aircrew. This paper describes the development of night vision aircrew training and, specifically, multimedia presentations used in such training.

Background

This section describes the existing physical facilities used for night vision device aircrew training, how night vision device video is acquired, and audio-visual training materials currently used in the field.

Training Facilities

The physical layout of facilities used for night vision goggle training has been standardized in the United States. The Air Force, Navy, and Marines all use similar configurations. The unit is known as a "NITE Lab" and can be housed in existing buildings (dependent on their layout), double-wide trailers, or new buildings.

A large portion of the NITE lab consists of the classroom. The classroom is normally configured to handle up to 15 students. Multimedia used in the training and the equipment necessary to do so are located in the classroom.

A terrain board is part of the facility. These boards range in size from 8 feet by 8 feet to 10 feet by 10 feet. The terrain board depicts a variety of terrain including an airfield, landing zones, cultural features, water, mountains, farmlands, desert, and forests. Several light sources are available but all are designed to provide light levels ranging from overcast starlight to full moon. The light source, when emulating the moon, can be moved around the board to simulate different moon angles. Students stand around the terrain board and observe various phenomena as presented and described by the instructor.

Another important element of the NITE lab is the eye lane. The eye lane is a light-tight room with minimum dimensions of 10 feet by 25 feet. The walls, ceilings, and floor all have a nonreflective finish. The room is equipped with various visual acuity resolution

charts and an illumination device. The illumination device emits light levels ranging from overcast starlight to full moon. The purpose of the eye lane is to provide a location in which the aircrew can be taught proper NVG adjustment and assessment procedures. Adjustment and assessment procedures are conducted in similar test lanes prior to night flying. These procedures enable aircrew to determine if their goggles are properly aligned and performing below, up to, or beyond specifications.

Finally, NITE labs are typically equipped with an office for use by the instructor. Storage space is also provided. Some have cockpit lighting simulators that demonstrate the effect of both NVG compatible and incompatible lights.

Night vision device flight simulation is also available at certain air bases. The quality of the simulated NVG imagery is usually low. UDRI and AL/HRA are currently developing an NVD simulator data base. It is hoped that the resultant product will prove to be the highest quality NVD flight simulator ever produced.

Night Vision Device Video Acquisition

A key element in the development of media for NVD aircrew training is the acquisition of video that shows various imagery as it would be seen through a specific device. The types of imagery recorded include the same scene under various illumination levels, misperceptions and illusions inherent to NVDs, various terrain types, and image peculiarities. Scenes are optimally recorded from aircraft but ground-based video is also used when appropriate and adequate. The night vision device video is then used to demonstrate various instructional points. This familiarizes the aircrew as to what they will be seeing prior to flying at night with NVDs.

Intensified imagery is gathered by interfacing an image intensifier to a video camera and then recording the camera's output. Numerous configurations of such cameras have been developed and it is up to the videographer or producer to use the configuration most appropriate for capturing the scene. This may mean using a full-size broadcast quality camera for ground-based applications , rigging a small monochrome CCD camera to the outside of a helicopter, or shooting with a hand-held camcorder in an ejection seat aircraft.

Acquiring infrared imagery is a more straightforward process. Most FLIRs are designed to be viewed on a video monitor. This means recording the images is a simple matter of taking the FLIR video output and connecting it to the video input of a videocassette recorder. The exception to this rule is that some targeting FLIRs are displayed and recorded at higher line rates than that of standard video. A scan line converter must be employed if such video is to be used as training media.

More aircrews are now flying on aircraft that use both FLIR and NVGs, which means the concept of sensor integration needs to be explained and demonstrated. This dictates the need to simultaneously acquire infrared and intensified imagery of the same scene. This is being done both on the ground and in the air.

A video library is now in place which contains all of the night vision video gathered so far. The library is by no means complete and is continually being expanded. Captured video is used in the development of night vision aircrew training and mishap investigations when and where it is needed.

Existing Training Media

Currently, several videotape programs are used for NVG training. A series of six video programs, ranging in length from 10 to 15 minutes, cover specific topics as they relate to flying with night vision goggles. The titles of the programs are NVG Image Characteristics, Lighting Issues, Luminance Variations, Terrain Albedos, Weather Effects, and Navigational Issues. Each program has numerous examples of intensified imagery documenting various NVG effects as they relate to the specific subject or topic being examined. These videos are used in a variety of ways. They can be viewed by the student either during the course or at their leisure during initial training. The programs are also used by NVG-qualified aircrew and viewed as part of their recurrency training.

Three instructional video presentations exist that teach proper NVG adjustment and assessment procedures. These programs are specific to a certain goggle type. Programs are currently available for ANVIS, CATS EYES, and F4949 NVGs. These programs are used during initial training and can also serve as a reference source for refresher training.

Graphic slides used during initial NVG training have been generated and are presented in several formats. These slides contain text and drawings used by the instructor during each lecture. There are currently six lectures within the initial NVG aircrew training syllabus. The current formats in use are overhead transparencies, 35mm slides, and computer presentation programs. The latter format entails the graphic slides being presented via a computer disk accessed from a viewer program. The instructor cues the host computer to change a slide when warranted. The computer display is normally projected onto a larger screen inside the classroom for easier viewing by the students.

Courseware Development

This section explains the process and the personnel used to create night vision aircrew training. Three areas are examined: subject matter expertise, instructional design, and media production.

Subject Matter Expertise

Experts in the use and design of night vision devices are the primary reference source for instructional content. Subject matter experts (SMEs) also provide input regarding the physiological effects that need to be considered when using NVDs. These people have determined the salient points that must be conveyed to the flier who will soon be using one or more NVDs. The concepts taught are constantly evolving based

upon operational experiences. Therefore, information is updated as needed and forwarded to other members of the multimedia development team. The SMEs also play a role in determining the order in which the instructional material is presented.

Instructional Design

Instructional design experts organize course content into a presentation based upon sound instructional principles. They take the input from the subject matter experts and place it within the various components that make up the course material. This material consists of the instructor's guide, the student handbook, and course administration guidelines.

Media Production

The media production personnel are responsible for creating all of the media used within the course. Typical team members participating in the development of NVD aircrew training include a graphic artist, a photographer, computer programmers, and a video producer. Media production is a time-consuming process due to the volume of material being generated, the need to assure technical accuracy, and quality control efforts (or "debugging") as they relate to delivery methods.

Multimedia Development and Delivery

This section describes how multimedia for NVD aircrew training is developed and delivered. The emphasis will be on the main method of courseware delivery that is used for initial NVG aircrew training. An alternate method of delivery will also be discussed.

Night Vision Goggle Training Course Interactive Videodisc

Courseware for the NVG training course is presented via an interactive videodisc. The videodisc is designed to be a multimedia instructor aid. All of the graphic slides and accompanying motion video segments for the entire course are contained on a single two-sided disc. The videodisc uses Level II programming which allows the instructor to navigate through the various lectures. A Level II interactive videodisc contains all of the navigational programming on the second audio channel. Each time the disc is loaded into a compatible player, the navigation program is loaded into the player's microprocessor thus allowing the courseware to be delivered. The presentation is presented to the class either on a large television monitor or on a screen via a video projector (Figure 1). The videodisc contains six academic lectures and three NVG adjustment and assessment lectures. The academic lectures are Introduction to the Course, The Human Visual System, Introduction to Night Vision Goggles, The Night Environment, Misperceptions and Illusions, and Night Operations. The adjustment and assessment lectures cover ANVIS, CATS EYES, and F4949 night vision goggles.

The current production disc is based on a prototype version produced in 1993. The prototype disc used the same delivery technique as the production disc but lacked

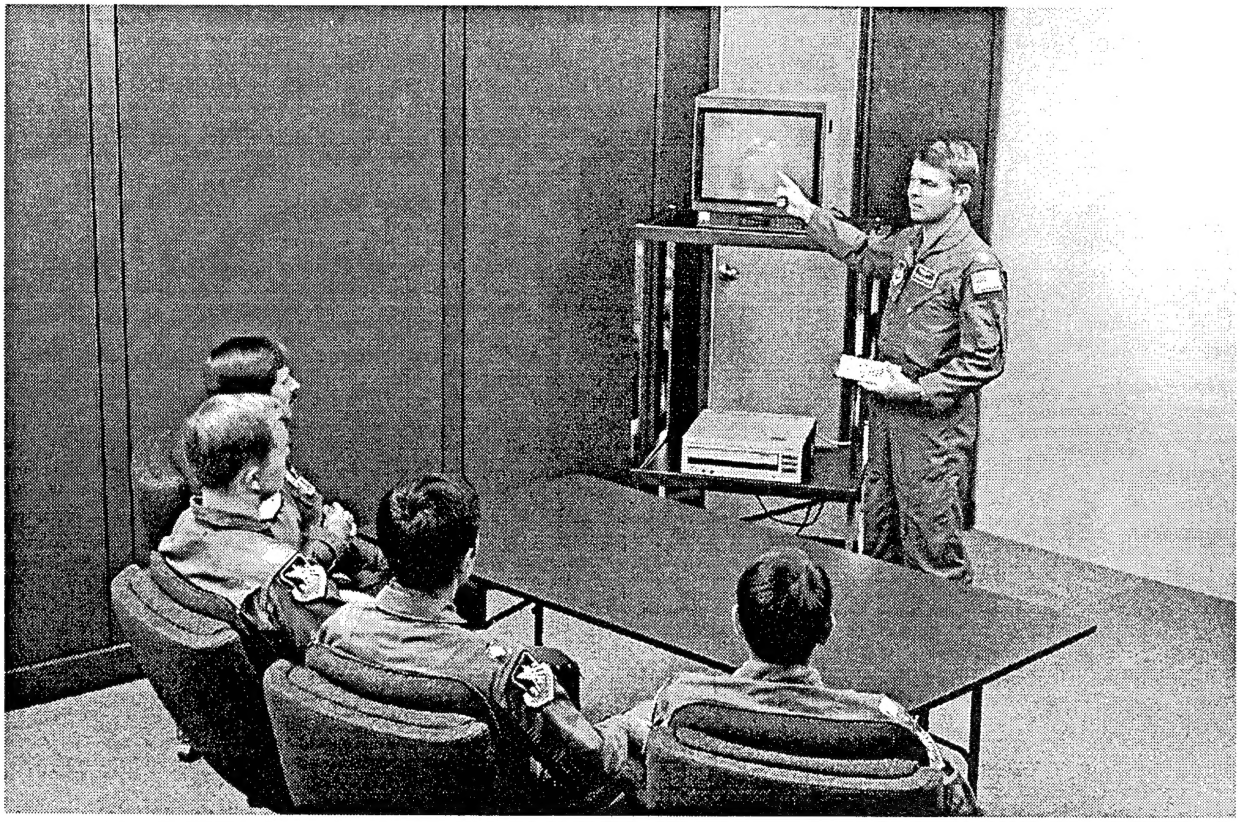

Figure 1. Night vision goggle training course presented in a classroom environment via a Level II interactive videodisc.

production quality. The graphics, the content, and the video production equipment used were all substandard when compared to the production disc. However, the prototype served its purpose as a concept demonstrator when presented to various flying and training units that would be using the final version. Changes to the production disc were made based upon input from multiple end users. The changes were significant and included limiting the amount of text on each graphic slide, making the graphics legible and increasing the resolution of the disc by editing on high-quality video production equipment.

Laser videodisc was chosen as a distribution format due to its high quality and ability to hold large amounts of data. The resolution of a videodisc is much better than that of VHS format videotape. This is a critical issue in the production of night vision aircrew training multimedia. Video acquired through image-intensified cameras has significantly lower resolution and reduced contrast than what is actually seen through a night vision goggle. Therefore, it is important to first record the intensified image on a high-quality videotape format and then minimize the number of generations each scene gathers when it is being edited into a final production. A generation occurs each time the videotape is copied. It is also important to preserve the quality of infrared video since it has inherently low resolution. The video production team also preserves image quality by editing to D2 videotape which is one of the highest quality videotape formats on the market.

The Night Vision Goggle Training Course Interactive Videodisc has been distributed to US Air Force, Navy, and Marine Corps NITE labs. The multimedia disc is part of the courseware package that includes instructor and student materials. Explicit instructions on how to install and operate the videodisc player are part of the package as well as instructions on how to navigate through the disc. Current plans call for the videodisc to be revised on a yearly basis. Revisions will be made based upon content review, changes in operational doctrine, equipment modifications, and operational lessons learned.

Alternate Delivery Method

An alternate way to deliver NVD training courseware has been devised. This was done in order to provide the courseware to those parties that might not have a compatible laser videodisc player. The alternate method uses 35mm slides as a storage medium for the graphic slides and a VHS videotape contains the motion video segments. These formats were selected due to the widespread availability of 35mm slide projectors and VHS videocassette recorders. Graphic slides with an accompanying motion segment have a prompt telling the instructor to play the appropriate motion video segment. The graphic slides can also be delivered via a number of different computer presentation programs thus eliminating the need for a 35mm slide projector. These alternate delivery methods virtually ensure that any unit can present the courseware to students even though there is a loss in image quality when presenting the motion segments on VHS videotape.

Future Multimedia Delivery

This section discusses how multimedia will continue to be used in support of night vision aircrew training. There are a variety of existing and emerging technologies which are suitable. The attributes, advantages, and limitations of each are examined.

Digital/Analog Delivery Platforms

There are plans to develop and deliver NVD aircrew training in a stand-alone desktop environment. One of the first products will likely be a Level III interactive videodisc for NVG training. Level III of videodisc interactivity is defined as a separate, external computer controlling the videodisc player as a peripheral device. This configuration combines the digital technology of the computer with the analog playback of the videodisc (Figure 2). Much of the content for such a videodisc would be based on the current course. The main differences between this strategy and the current course are that the students pace themselves through the material and no instructor is present. Some type of testing will be embedded into the Level III programming to ensure student comprehension of the subject matter. The analog videodisc would contain only the motion video segments for the course. The graphic slides would be stored digitally on the host computer.

Emerging Digital Technologies

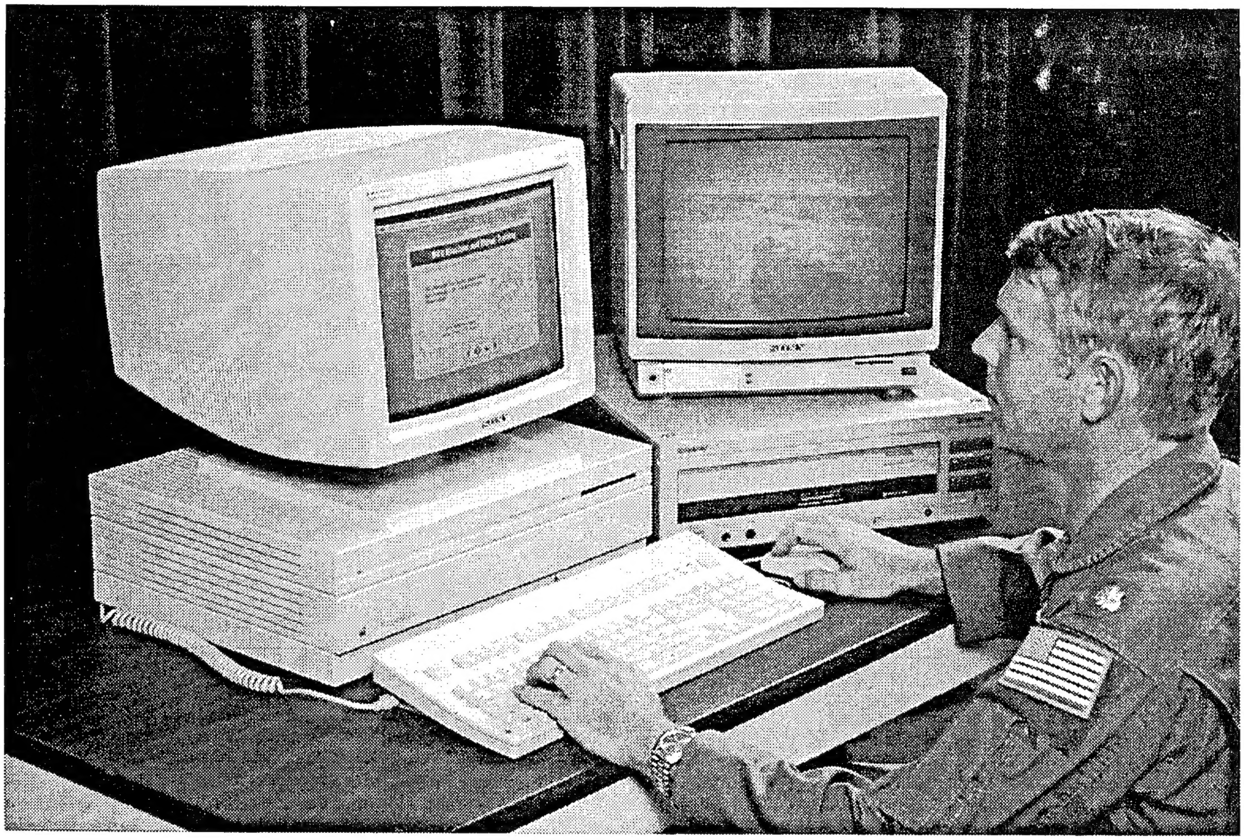

Figure 2. Self-paced night vision device training presented interactively via a computer and videodisc player.

Several digital technolgies are now on the market specifically designed to capture, store, manipulate, and display video. An analog video signal that is converted into digital data takes up a large amount of storage space. Encoding a single frame of NTSC video into digital RGB format generates a file of approximately 700 kilobytes. Considering that there are 30 frames in a second of motion video, one can see that storage quickly becomes a limiting factor. This does not take into account the retrieval times of digital video information assuming that one would like to play back a motion segment in real time. The emerging digital video technologies typically use a compression technique to limit and control the amount of storage space required. The tradeoff is that image quality is degraded by these compression techniques. Image quality, as stated above, is an important issue when dealing with intensified and infrared imagery. The issue of how much degradation is acceptable must be addressed prior to employing any digital video technology.

Digital Video-Interactive, or DVI, is a format that requires source videotape be sent to a compression facility for the highest quality processing. The digital video is delivered to the customer in whatever digital data format is desired. This could be CD-ROM, hard disk, or data tape. DVI compression stations can be acquired but they are expensive and do not provide the highest-quality compression technique. Playback requires a

computer board which contains the Intel 750i chip. There are several resolutions available in this format ranging in quality comparable to VHS videotape on the low end to one with resolution just less than that of a recordable laserdisc. DVI plays back video at 30 frames per second in a full screen configuration. It is well-suited for interactive applications. Two proof-of-concept DVI programs are currently being developed at AL/HRA. One is a post-test for use after the initial NVG training course. The other is a course demonstrating the NVG terrain board.

Another compression technique that has been analyzed for use in NVD aircrew training is MPEG compression. MPEG compression can be performed on a desktop computer fitted with an MPEG encoder board. The MPEG encoder being tested by the US Marine Corps was acquired for US $19,500.00. Compression can be performed at several resolutions. Higher resolutions generate larger digital files. MPEG files can be played back at 30 frames per second on a full screen.

There are other ways to store digital video. Many techniques require the user to record at 10 to 15 frames per second and will only display the video in a small window on a computer screen. These techniques are adequate when the viewer does not need to see important visual information during playback. However, this is a limiting factor as it relates to night vision device video where a main consideration is preserving image quality such that it does provide the audience with critical visual information.

Future Courseware Development

Courseware is also being developed in two other areas. One is NVD training that is specific to an aircraft and/or a mission. Video-based instruction is also being produced for infrared sensors.

Aircraft/Mission Specific Training

The current course used for initial NVG aircrew training is generic in that it does not address any specific aircraft type or mission. However, there is a need for weapon system and mission specific training. Night vision video can be used to document and then display specific aircraft maneuvers or operational techniques to the aircrew. Video can also be used to document night training routes. An experienced crew flies a route with a night vision camera recording the scene. This video can then be played back to others prior to their flying the route for the first time. This will allow the experienced crew to point out critical segments or potentially hazardous points within the route.

How such specific training media is packaged and delivered to a community is approached on a case-by-case basis. It is important to know what the instructors within that community are trying to convey and what audio-visual equipment is available to present the end product. One aircraft and mission specific training program has been delivered. It is a 15-minute videotape describing the visual identification intercept as performed at night by F-15 and F-16 aircraft in which the crews use NVGs.

Forward Looking Infrared Training

Training material that covers the operation and employment of airborne infrared sensors is being produced. The initial FLIR training course is being created for fixed wing and helicopter crews from the US Marine Corps. This course is being developed using the same delivery techniques as that of the initial NVG training course. It is yet to be determined what media will be employed. It is anticipated that the first version of the course will be comprised of an instructor's guide, a student handout, graphic slides, and a videotape. Videotape is being gathered showing a variety of terrains, environmental conditions, image characteristics, and image adjustments as seen through a FLIR. Sensor integration will also be demonstrated by showing the same scene through both NVGs and a FLIR. A follow-on version of the training may include a Level II interactive videodisc similar in structure to the NVG training course videodisc.

Summary and Conclusion

This report has described previous and ongoing efforts to develop and deliver night vision device aircrew training multimedia. It has covered technologies and techniques currently in use and has described emerging technologies that may be used in the future.

It is anticipated that digital video technologies will continue to develop and improve in such a way that they will be suitable for night vision aircrew training. Currently, that is not the case. However, proof-of-concept applications are being produced to demonstrate the capabilities of these interactive technologies. Personnel will continue to study and keep abreast of improvements in these and other presentation media.

It is important to deliver quality aircrew training using the most appropriate hardware and software. Decisions on which technologies to use must take into account cost, ease of operation, and image fidelity. The true test of training quality is its effectiveness and its ability to enhance mission safety.